Forest Engineering and Operations Research and Development

A Strategic Pathway for Implementing Healthy Forests Restoration Activities

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USDA Forest Service Research & Development

The Problem

Overstocked stand in northern Idaho

Millions of acres of the Nation's forestlands are facing a wide range of problems that need to be addressed; most require active forest management to restore health and natural processes. From insect outbreaks to the spread of invasive plants to the overcrowding of forests with small-diameter trees and fuels, these problems are resulting in high tree mortality, loss of wildlife habitat, fire threats to life and property, and widespread ecological and environmental impacts. A primary cause of unhealthy and threatened forests is the elimination of significant stand disturbance due to successful fire suppression along with the reduction or lack of other management activities such as commercial timber harvests. Without periodic disturbance many forest types become overcrowded and susceptible to various kinds of forest health degradation. The landscape-scale diversity of stand structures and ages is also reduced. The problem is clearly understood at the national level, resulting in widespread support for the National Fire Plan and the Healthy Forest Restoration Act. Both of these policies recognize a pressing need for action on the ground to improve the condition of our nation's forests.

Science-based prescriptions are under development and are being applied to restore forests. Generally, the treatments involve reducing or removing the accumulated biomass now present in many of our forests and creating a stand structure that can be maintained by natural processes and management activities. Some forest health issues such as the wildland urban interface and exotic invasive plants may require management actions that use not only natural processes, but more intensive restoration treatments. The science of forest and resource management tells us what needs to be done; public policies provide incentive and direction; now managers need the tools to turn those prescriptions into accomplished projects on the ground.

We are discovering that *a critical barrier to successful implementation of the Healthy Forest Restoration Act is finding the right methods and tools* to conduct forest treatments for hazardous fuels reduction and restoration. The basic problem is a lack of tools that are both technically and economically feasible to implement prescriptions and treatments and a lack of knowledge to support successful operational planning and implementation.

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[1] This document is the result of collaboration between the Forest Operations Research and Development program within Forest Service R&D and representatives from universities and other collaborating organizations.

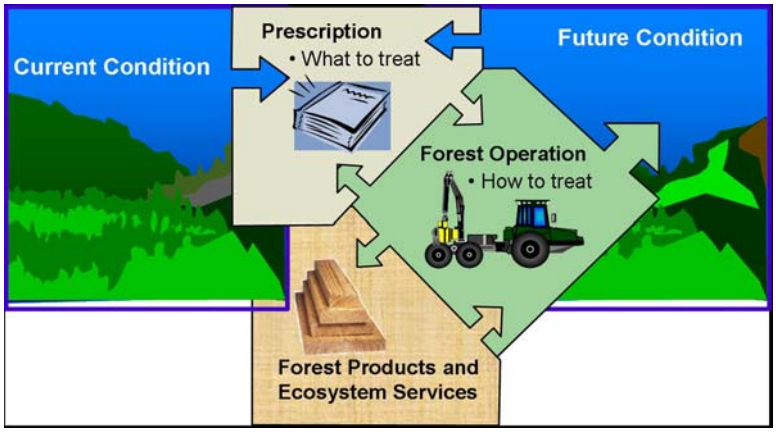
The Special Problem of Forest Operations for Healthy Forests

Like any tool, a forest operation is designed to perform a specific job in the most efficient manner. Forest operations must be designed to match the requirements of the task as well as the operational constraints imposed by terrain, costs, and regulation. Equipment designed to cut merchantable trees may be too costly for small-diameter thinnings. Using ground-based equipment on steep slopes may result in excessive soil disturbance and erosion. The inability to find appropriate forest operation tools to execute forest health prescriptions is a significant barrier to implementation of the HFRA. Problems often facing managers in implementation of health and stand restoration activities include:

1. Lack of suitable infrastructure (contractors, equipment, access, markets)
2. Lack of a trained workforce for partial cuts, thinnings, and biomass removal (contractors and resource managers)
3. Lack of technically feasible systems and equipment to perform new tasks (e.g. thinning on steep slopes, in crowded stand conditions, comminution of brush and slash, etc.)
4. Lack of economically feasible tools to get maximum acres treated with available resources
5. Lack of operations, systems, and technology that can transport biomass and low-value products economically to wood-consuming facilities
6. Lack of synthesis of research knowledge and easily accessible decision tools to support practical applications
7. Lack of knowledge of ecological impacts and methods and technologies to eliminate or mitigate those impacts

A goal of Forest Engineering and Operations Research and Development is to support implementation of effective forest management by addressing these barriers.

Forest Operations are the Tools to Achieve Healthy Conditions on Many Stands



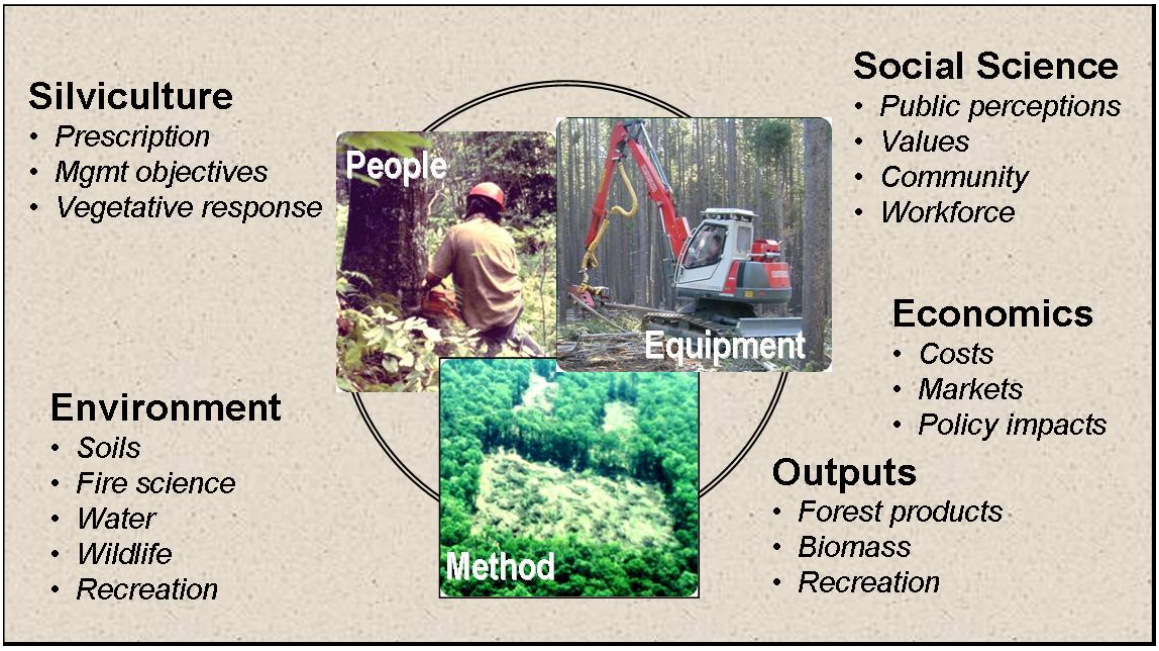
Forest operations are the primary mechanism for converting forest management plans into the realization of desired future conditions. Forest operations are generally physical actions which change the forest, altering structure, composition, condition, or value in order to meet society's needs for clean air and water, forest products, wildlife, recreation, healthy forests and other benefits. Activities include a wide range of actions such as thinning, regeneration harvests, planting, access construction and maintenance, prescribed fire, and fuels treatment. Forest operations include a broad array of technologies and systems to accomplish these activities. They can range from manual operations with chainsaw crews to sophisticated equipment for low-impact harvesting. While forest

operations provide many benefits, they may have some negative impacts on forest soils, vegetation, and watersheds unless appropriately applied and managed.

Proper forest operations are of value to landowners and society through improved forest conditions and product outputs generated in an economical and environmentally acceptable manner. The requirements of a management prescription help define the forest operation just as the limitations of the forest operation help define the prescription. Similarly, the types of ecosystem outputs establish requirements for the forest operation. Caring for the land and serving people means having the ability to execute management treatments across the landscape. Resource managers need access to a broad array of forest operations tools and the science and knowledge to properly apply them.

The Forest Engineering and Operations Research and Development Approach

A forest operation is a complex system of people, equipment, and methods to implement management prescriptions within physical, ecological, economic, and social constraints. Therefore, the research approach is also complex, integrating basic scientific disciplines of engineering, forest ecology, silviculture, human science, economics, and forest products. We must build on this underlying science and knowledge base to develop and apply innovative technology and better management of machines and systems to improve performance.



Current Capacity in Forest Operations Research in Forest Service

USDA Forest Service R&D has three Forest Operations and Engineering Units across the country. The unit in Moscow, ID has a national scope to focus on impacts of management and natural disturbances on forest soil and water, and on the construction, management, and removal of forest roads. In Morgantown, WV, the focus is on eastern cable logging and systems for hardwood stand management. The unit in Auburn, AL has a national scope to examine a wide range of technology for stand management and to evaluate and manage the ecological effects and economics of fuel reduction and forest restoration. In addition, a component of the Seattle, WA

unit addresses stand visualization and planning tools. In Portland, OR the team on Ecologically Sustainable Production of Forest Resources focuses part of its work on linkages between forest operations and wood quality and is also concerned with technological and economic feasibility of operations for recovering forest products from stands treated for fuel reduction. These units represent a multi-disciplinary science team, with soil scientists, hydrologists, silviculturists, and industrial, civil and biosystems engineers.

However, the capacity is also defined by a high degree of collaboration and coordination with researchers outside the Forest Service. Forest Service units and scientists collaborate with other forest operations and engineering professionals in order to extend capacity for additional researchers and to obtain specialized support as needed. Collaborative studies with universities, the forest industry, and other organizations expand the scope and capabilities of the core FS research program. These organizations have ongoing research programs that address forest operations restoration activities. Collectively our coordination in this common framework advances solutions in an efficient manner.

Proposed Actions to Support the Healthy Forest Restoration Act and the National Fire Plan

Current research programs are addressing some of the key knowledge gaps. Further work will be directed towards many of these specific critical research needs:

1. Basic information about how well forest operations perform with smaller diameter material
2. Evaluation of new technologies for recovering biomass for energy
3. Development of more efficient systems for harvesting, extracting, and processing of small-diameter trees
4. Basic knowledge about the costs, operational performance, and outcomes of mechanical fuels treatments such as mastication and thinning
5. Basic knowledge about the ecological effects of mechanical treatments on soil, water, and vegetation
6. Development of new technologies for low-impact operations on steep slopes and sensitive soils
7. Synthesis of machinery and systems information into decision tools that can be applied in new prescriptions to aid in integrated planning
8. Development of planning tools to help coordinate operations over multiple entries and improve site management
9. Development of systems and technologies to improve recovery and utilization of material in conventional harvest and fuel reduction activities
10. Improved transportation systems for low-value biomass to reduce costs

Visit our Units' websites for more information

Washington Office, R&D
www.fs.fed.us/research/vmpr.html

Forest Operations Research Auburn, AL
www.srs.fs.usda.gov/forestops

Soil and Water Engineering Moscow, ID
forest.moscowfsl.wsu.edu/engr

Integration of Forest Operations Into Eastern Hardwoods Morgantown, WV
www.fs.fed.us/ne/morgantown/4751/

Silviculture and Forest Models Seattle, WA
www.fs.fed.us/pnw/about/programs/rmp/westside.shtml

Ecologically Sustainable Production of Forest Resources Portland, OR
www.fs.fed.us/pnw/about/programs/hnri/ecological-sustain.shtml

Strategic Path for Forest Operations Research, Development and Deployment

Goal	Barriers to progress	Research Needs	Approaches	Deliverables
Increase acres treated under HFRA through improved economic and technical performance of forest operations	Lack of technically feasible systems and equipment to perform new tasks (i.e., steep slopes, operations, mastication, biomass compaction)	Understand performance requirements of treatments Understand operational constraints of stands Integrate silvicultural and operational requirements Evaluation of new technology for application	Resource characterization Engineering studies Equipment development	Assessment reports Project reports defining engineering requirements New equipment prototypes Operations guidelines
	Lack of economically feasible tools to get maximum acres treated with available resources	Understand cost components Productivity of existing and new technology in forest health treatments	Time studies Cost/benefit analyses Economics	Improved economic analysis tools
	Lack of decision tools/synthesis of research knowledge into practical applications	Develop robust models of system performance Connect spatial data to performance models Synthesis of applications information	Database compilations Literature review Science synthesis Targeted studies to fill in gaps	Operating specifications Handbooks and training material Annotated bibliographies Synthesis reports
	Lack of ecologically acceptable operations for some conditions	Understand the interaction of equipment and soil Develop science-based criteria for acceptable impacts	Soil studies Erosion studies Predictive tool development Engineering studies of low-impact technology	Effects models Operating recommendations Decision tools Predictive tools
	Lack of a trained workforce (contractors and sale administrators)	Understand knowledge needs and delivery modes Application tools to aid decision-making	Decision tools and models Technology transfer	Workshops Training materials Knowledge tools
	Lack of infrastructure (contractors and equipment)	Improve transport models Business models	Work with S&PF, RC&D, Cooperative extension services, State forestry and logging associations	Technical assistance to new ventures

	Lack of market linkages	Business analysis Risk analysis Resource assessments and analysis	Work with state and rural economic development agencies, USFS Forest Products Lab, Dept of Energy, and USFS Forest Inventory and Analysis	Strategies for economically-viable forest operations Resource availability reports